

Northeastern Forest Experiment Station

Upper Darby, Pa.

QUARTERLY REPORT ON

FOREST INFLUENCES AND FLOOD CONTROL SURVEYS

April 1, 1952



FLOOD CONTROL SURVEYS

by Norman R. Tripp

STATUS OF FLOOD CONTROL SURVEY REPORTS

Connecticut River.--In Secretary's Office for final review.

Merrimack River)--Comments received on review drafts--awaiting  
Salt River ) clarification of policy and instructions from  
Washington Office before preparing final drafts.

Allegheny River.--First draft in progress.

Upper Susquehanna and Monongahela Rivers.--No further progress.

Potomac River (Review Report).--Work plans set up--field work to start in April.

NE--NYIAC--RESOURCES SURVEY

The compilation of data collected in the field last summer and from secondary sources during the winter is largely completed. Tentative programs for land treatment have been set up subject to check and revision as the results of the hydrologic and economic analyses become available. Present land use and condition and probable future use and condition after installation of the program have been tabulated and summarized.

Work plans and schedules have been prepared for the coming field season.

Assuming no drastic changes in the nature of the survey or in the manpower and money situation, we should finish all necessary field work this summer and be in good shape to submit final data and preliminary reports to the Study and Report Groups by late fall.

The usual number of meetings, conferences and similar sessions were attended by various members of the staff. If talk will do it, this should be one of the best reports ever.

## FOREST INFLUENCES

by Herbert C. Storey

### Frost Study

The study of soil freezing in the Northeast was continued this year by renewal of observations of snow and frost on the same plots as used last year.

Temperatures during the present winter averaged lower in November and December than for the 1950-51 winter, but January and February, 1952, were not as cold as the same months in 1951. For example, at the Bartlett Experimental Forest the accumulated deviation from 32 degrees of the daily mean temperature was 215 degrees as of the end of December, 1950, 515 degrees by the end of January, 1951, and 730 as of the end of February. The present winter shows 360 degrees at the end of December, 1951, 634 degrees at the end of January and 833 at the end of February.

Snowfall during the present winter has been considerably more than for the 1950-51 season. Accumulation of snow has been several times greater on the forest plots than on the open-land plots. Table 1 shows snow depths and density as of the end of each month for each land use and condition studied near Bartlett, New Hampshire. It will be noted that by the end of February, snow depths on the open-land plots were considerably less than on the forest plots while snow densities on the open-land plots were greater.

Concrete frost in the Bartlett area as of the end of each month through February has been confined nearly entirely to the open-land plots, table 1. The clear-cut plots show some patchy concrete freezing, but the remainder of the forest plots have none. This lack of concrete frost may be attributed in part to the heavy snow pack. It is interesting to note that on the hay land, pasture, and abandoned pasture, when snow accumulation reached 21-29 inches, concrete frost depths started to decrease. The bare plots show no decrease in concrete frost even with a snow depth of 23 inches.

### General

During the past month arrangements were made to supply the U.S.G.S. district office at Boston with snow and frost data from our study areas near the Hopkins and Bartlett Experimental Forests. This information will be incorporated by the U.S.G.S. in the monthly water bulletin covering New Hampshire, Vermont, Massachusetts and Connecticut.

TABLE 1.--SNOW AND FROST NEAR BARTLETT EXPERIMENTAL FOREST, 1951-52

| Land Use<br>or<br>Condition                | November <u>1/</u> |         |                    |        | December <u>1/</u> |        |                    |         | January <u>1/</u> |         |                    |        | February <u>1/</u> |        |                    |         |
|--------------------------------------------|--------------------|---------|--------------------|--------|--------------------|--------|--------------------|---------|-------------------|---------|--------------------|--------|--------------------|--------|--------------------|---------|
|                                            | Snow               |         | Concrete:<br>Frost |        | Snow               |        | Concrete:<br>Frost |         | Snow              |         | Concrete:<br>Frost |        | Snow               |        | Concrete:<br>Frost |         |
|                                            | Inches             | Density | Inches             | Inches | Density            | Inches | Inches             | Density | Inches            | Density | Inches             | Inches | Density            | Inches | Inches             | Density |
| Bare,<br>cultivated                        | 8                  | 15%     | 3                  | 5      | 18%                | 6-7    | 18                 | 27%     | 7                 | 23      | 34%                | 8      |                    |        |                    |         |
| Hay land                                   | 9                  | 14%     | 2.5-3              | 6      | 15%                | 5      | 22                 | 28%     | 4                 | 28      | 33%                | 2.5-3  |                    |        |                    |         |
| Pasture                                    | 8                  | 10%     | 3-3.5              | 14     | 14%                | 5-5.5  | 21                 | 29%     | 4.5               | 29      | 32%                | 1-2.5  |                    |        |                    |         |
| Abandoned<br>pasture (some<br>nat. repro.) | 10                 | 9%      | 0                  | 14     | 14%                | 3.5    | 29                 | 24%     | 1                 | 43      | 30%                | 0      |                    |        |                    |         |
| Clear-cut (good<br>repro.)                 | 10                 | 9%      | 0                  | 24     | 14%                | 0      | 34                 | 22%     | 0                 | 47      | 25%                | 0-1    |                    |        |                    |         |
| Clear-cut (poor<br>repro.)                 | 10                 | 9%      | 0                  | 20     | 17%                | 0-2    | 33                 | 24%     | 0                 | 55      | 22%                | 0      |                    |        |                    |         |
| Conif. pole                                | 6                  | 10%     | 0                  | 22     | 15%                | 0      | 28                 | 26%     | 0                 | 46      | 26%                | 0      |                    |        |                    |         |
| Hardwood pole                              | 10                 | 12%     | 0                  | 24     | 14%                | 0      | 33                 | 24%     | 0                 | 51      | 23%                | 0      |                    |        |                    |         |
| Old conif.<br>plantation                   | 6                  | 5%      | 0                  | 20     | 17%                | 0      | 30                 | 24%     | 0                 | 44      | 23%                | 0      |                    |        |                    |         |
| Hardwood saw-<br>timber<br>undisturbed     | 10                 | 12%     | 0                  | 21     | 16%                | 0      | 33                 | 29%     | 0                 | 56      | 25%                | 0      |                    |        |                    |         |

TABLE 1. (CONT'D) - SNOW AND FROST NEAR BARTLETT EXPERIMENTAL FOREST, 1951-52.

| Land Use<br>or<br>Condition             | November <sup>1/</sup> |         |                    | December <sup>1/</sup> |         |                    | January <sup>1/</sup> |         |                    | February <sup>1/</sup> |         |                    |
|-----------------------------------------|------------------------|---------|--------------------|------------------------|---------|--------------------|-----------------------|---------|--------------------|------------------------|---------|--------------------|
|                                         | Snow                   |         | Concrete:<br>Frost | Snow                   |         | Concrete:<br>Frost | Snow                  |         | Concrete:<br>Frost | Snow                   |         | Concrete:<br>Frost |
|                                         | Inches                 | Density | Inches             | Inches                 | Density | Inches             | Inches                | Density | Inches             | Inches                 | Density | Inches             |
| Hardwood saw<br>timber logged           | 11                     | 10%     | 0                  | 22                     | 15%     | 0                  | 34                    | 23%     | 0                  | 57                     | 22%     | 0                  |
| Coniferous saw<br>timber<br>undisturbed | 6                      | 5%      | 0                  | 20                     | 15%     | 0                  | 29                    | 24%     | 0                  | 47                     | 27%     | 0                  |
| Mixed saw timber:<br>undisturbed        | 6                      | 10%     | 0                  | 18                     | 17%     | 0                  | 34                    | 22%     | 0                  | 43                     | --      | 0                  |
| Coniferous saw<br>timber logged         | 6                      | 5%      | 0                  | 17                     | 20%     | 0                  | 30                    | 23%     | 0                  | 43                     | 22%     | 0                  |

<sup>1/</sup> Depths as of the end of each month.

## FOREST INFLUENCES

### DELAWARE BASIN RESEARCH CENTER

by the Delaware Basin Staff

#### Water Relations

Precipitation at the Dilldown Watershed Unit during the first four months of the hydrologic year has continued at the high level of last year. Streamflow measured at the gaging station has also remained at the higher level. The following tabulation compares the records for the first four months of each hydrologic year so far:

#### Precipitation and Streamflow for Period October 1 to January 31

|                                           | Hydrologic Year |                |                |                |
|-------------------------------------------|-----------------|----------------|----------------|----------------|
|                                           | <u>1948-49</u>  | <u>1949-50</u> | <u>1950-51</u> | <u>1951-52</u> |
| Precipitation - inches                    | 17.68           | 13.18          | 23.27          | 24.17          |
| Streamflow - inches over<br>the watershed | 8.44            | 7.06           | 13.93          | 14.31          |

Final computations have been made on the streamflow peaks resulting from the two very heavy storms late in 1950. These were the two storms that caused flood conditions in many parts of the Northeast and considerable damage and blowdown from the accompanying high winds. At the Dilldown watershed, the first storm, on November 25, caused a peak flow of 150 cubic feet per second. The peak flow from the second storm, on December 4, was even higher, 165 c.f.s. The latter figure amounts to almost 75,000 gallons per minute--a considerable flow from a small stream such as Dilldown Creek. On an area basis, the flow was 69 cubic feet per second per square mile (c.s.m.).

It is interesting to note that little or no sediment has been deposited in the pool back of the weir, even after these high flows.

Numerous streamflow measurements with a current meter or velocity-head rod have been made at the Pocono Experimental Forest during the quarter in order to calibrate the streamgaging station at that place. The relationship of discharge to gage height is not yet complete but appears to be similar to the Dilldown relationship, although at a slightly lower level.

#### Interception

Analysis of last year's interception data was continued during the first part of the quarter. The equation for stemflow from rhododendron has

been revised from that given in the previous quarterly report, due to the discovery of significant differences between summer data and spring and fall measurements.

During the summer,  $SF = 0.244P - 0.013$  in which  $P$  = total precipitation per storm in inches. Even though rhododendron is evergreen, stemflow before the middle of May and after the middle of September is lower than estimates from the above equation.

This revision changes the equation of total interception loss in the high forest of mixed hardwoods and conifers at the Dilldown Watershed Unit to:

$$I.L = 0.138 P - 0.019$$

Thrufall measurements made at the Pocono Experimental Forest have also been analyzed. Data from each of the two installations in hardwood stands are very similar, resulting in the following average equation:

$$T = 0.77 P - 0.014$$

Both stands are of medium density and consist of small sawlog-size tree with intermingled pole-size trees.

The third installation is in a stand running mainly to pole-size conifers. The equation for thrufall in this stand is not greatly different from the above:  $T = 0.79 P - 0.023$ .

Stemflow measurements are still too few to show a consistent relationship but the data to date indicate a considerably higher amount of stemflow per size of storm than has been found in the high forest at the Dilldown watershed. Frequently, last summer, the collector cans on pole-size, smooth-bark trees (beech and red maple) were overflowed by stemflow. The data that were obtained indicate that the 8-inch beeches will each collect about 40 gallons of water in a 2-inch storm, while the 9-inch maples need a collector can capacity of 25 gallons for two inches of rainfall.

All interception and stemflow measurements will be continued this year.

#### Riparian Water Loss

The relationship between riparian water loss and other factors for which we have known measurements was studied in considerable detail during the quarter. Riparian water loss, the loss due to evapo-transpiration in the stream-bed zone, is the difference between base ground-water flow and daily streamflow only when streamflow is not affected by storm runoff. As streamflow is affected by stormflow for two, three, or four days after each storm, no direct measurement of this loss can be obtained on probably the

majority of the days during the seasons such loss occurs. On these days it is necessary to estimate the loss, preferably by its relationship with other factors.

Using days in which the direct measurement could be obtained, riparian water loss was related, first, to base ground-water flow. This, obviously, is a measure of the amount of water available for evaporation and for use by the vegetation in the stream-bed zone. The correlation was found to be highly significant.

Next, weather conditions, temperature and humidity, would logically affect the amount of evapo-transpiration. Saturation deficit, a factor combining temperature and humidity, was related to loss and also found highly significant. Numerous forms of this factor were tried and the best estimate was obtained by the following:

Log 100 Saturation Deficit, - with saturation deficit being a 3-day running average computed as follows:

$$S.D. = \frac{4(S.D_1) + 2(S.D_2) + (S.D_3)}{7}$$

in which  $SD_1$  = Saturation deficit of the day in question

$SD_2$  = " " " " previous day

$SD_3$  = " " two days previously

The two variables together in a multiple equation estimated losses very well, but an interaction of the two estimate even closer.

The final equation derived is as follows:

$$R.W.L. = 0.0054 BF \times \log 100SD - 0.0044$$

in which:

R.W.L. = daily riparian water loss in inches

B.F. = daily base ground-water flow in inches

S.D. = saturation deficit as derived above

Other variables such as wind and temperature were tried but were not significant.

It is proposed that this equation be used for all days when base flow is greater than daily streamflow, but when daily streamflow is the higher--during and after storms--it will be substituted for base flow in the above equation. In this case, daily flow will be a much better estimate of available water than base flow.

## Soil Moisture Studies

### Evapo-transpiration losses

The multiple regression analysis of evapo-transpiration losses of soils at Dilldown is not completed. However, a few remarks are in order. One outstanding fact is that evapo-transpiration losses are directly related to the saturation deficit of the air. All our analyses to date indicate that this climatic variable is the controlling factor. In all of the cases studied, 48%-49% of the total sum of squares may be attributed to a function of the saturation deficit (its logarithm). It is also interesting to note that the regression coefficient of this variable is directly related to the texture of the soil. The more sandy soils have smaller coefficients; the soils with more clay have larger coefficients. In other words, for a given saturation deficit, evapo-transpiration losses are smaller on the light textured soils than on the heavier soils.

Among the other variables studied (air temperature, soil moisture content, wind velocity and length of time elapsed since the last storm) only one (time) appears to be statistically significant. Contrary to expectation, in the Dilldown area the amount of moisture in the total soil horizon apparently has little effect on evapo-transpiration losses. These tentative results lead us to believe that soil moisture content does not greatly limit evapo-transpiration losses until the soil moisture content is reduced to a level close to the wilting point of the soil. In the area of study the soil moisture is always well up near field capacity for the profile as a whole.

### Infiltration rates on frozen ground

A preliminary study was initiated to determine the relative rates of infiltration on soils frozen to different degrees of compaction. That is, one of the questions asked was: A given soil has: no frost, granular frost, honeycomb frost or concrete frost; what is the relative infiltration rate in each of these conditions. Unfortunately, we were able to sample only concretely frozen soil (both forested and bare). The data have not yet been analyzed. We may, however, say that when bare soil is concretely frozen, the infiltration capacity is zero; when a forest soil is concretely frozen, the infiltration capacity may be high. This points to a range in structure of what we classify as "concrete" frost and may be related to moisture content when freezing occurs.

### Calibration of soil moisture units

During the past six weeks we have been calibrating a dozen Colman units in a pan full of fine sand. The sand has lost a large amount of water during this period, but the resistance of the units (as indicated on the Colman meter) is still at the initial starting point. As far as we know, there is no free water in the bottom of the pan. This phenomenon leaves room for a great deal of speculation. Any suggestions?

### Miscellaneous

Reigner spoke to the Bethlehem Area Council of the Boy Scouts on the subject "Conservation Problems in the Lehigh Valley." The group was composed of leaders and older scouts (explorers).

Bethlahmy was guest lecturer at one session of Prof Jenkins' class in conservation, speaking on soil coloration.

Reigner attended the annual meeting of the Pennsylvania Forestry Association at Split Rock Lodge in the Poconos.

## MOUNTAIN STATE RESEARCH CENTER

by the Mountain State Staff

### Watersheds Calibrated

A series of volumetric checks have been made on our 120° V-notch weirs to compare the actual discharge against the experimental discharge determined by the formula  $Q = 4.43H^{2.449}$ .

These volumetric checks were made using a stop watch, scales, large basin and a small section of pipe. The pipe is attached to the downhill side of the weir blade. The water is caught in the basin and time recorded to seconds and tenths of seconds. The water is weighed and converted to cu.ft. per second.

Of the five blades two checked without deviation. Three of the five blades showed a deviation from the equation for low flows. The actual volume was greater than the theoretical volume determined from the equation. In all three cases, the difference between actual discharge and theoretical discharge diminished with increase in head (H). No difference was apparent in the head above point .260 feet for any weir.

New rating curves were established for each of the three weirs. Periodic checks will be made to adjust any shift in the rating curve.

### Office Computations Reduced

The office work involved in tabulating and computing runoff has been reduced approximately 50 percent through a change in method of marking the charts. The procedure was worked out with the help of the local U. S. Geological Survey office.

Here, briefly, is the procedure used:

1. Minor breaks in the stream hydrograph are no longer marked. Breaks in the hydrograph are made only where there is an appreciable rise or fall in discharge (except that midnight, peak flows, and storm beginnings are always marked). The allowable rise or fall before a break is indicated depends on the head and has been worked out and tabulated in a range table. This range table indicates the maximum rise or fall which is permissible at a given stage.

The permissible rise or fall is determined by the following rule: "Breaks in the hydrograph are made when the difference in discharge between consecutive heads exceeds  $1\frac{1}{2}$  times the difference in discharge between heads where the previous break was made." To illustrate with the rating table for the 120° V-notch weir: Assume that the head at the initial point on a hydrograph (starting point on a chart) is .056'. Between heads of .055' and .056'

there is a difference in discharge of .0002 c.f.s. Therefore,  $.0002 \times 1\frac{1}{2} = .0003$  c.f.s. Assume there is a rise in stream flow. Now go up the rating table to find two consecutive heads with a difference in discharge greater than .0003 c.f.s. that is .0004 c.f.s. This difference lies between heads of .088' and .089'. Therefore, at a head of .056' a rise of .033' is permitted before marking the chart. By starting at the lowest stage for any weir and plotting permissible increases in head over head a curve is obtained from which range table values can be read. Below is a section of range table obtained using values from the rating table for the 120° V-notch weir.

| <u>Heads<br/>(feet)</u> | <u>Permitted Increase in Head<br/>(feet)</u> |
|-------------------------|----------------------------------------------|
| .601 - .650             | .170                                         |
| .651 - .700             | .180                                         |
| .701 - .750             | .200                                         |
| .751 - .800             | .210                                         |

2. Once the breaks have been established, a dot is placed mid-way (in time) between the marked points or breaks. The exact head, or vertical location, of this dot is determined by laying a straight edge horizontally through the dot and balancing areas above and below the line on each side of the dot. Discharge is recorded only for the head represented by the dot. This is multiplied by the time interval to obtain interval discharge.

Step one results in a saving because less than half as many points are marked on the hydrograph under the new system. Step two results in a saving because only one entry for c.f.s. discharge is now necessary. Under the old system it was necessary to enter discharge for each break and then average it for the interval.

This method has been designed to operate within an error of 2% plus or minus. Weekly discharges determined by this new method when compared to the discharges determined by the old method have shown a difference of less than 2 percent.

#### How Long Does Skid Road Erosion Last

The second year measurements on skid road erosion on Area #1 have been made. Erosion from this area after the first year was previously reported. This measurement gives an indication of how long skid road erosion on non-bulldozed skid roads will continue:

Table 1.--Trend in post-logging skid road erosion--Area #1.

| Slope<br>(percent) | Distance Below<br>Drainage Outlet<br>(feet) | Number Cross<br>Sections<br>Measured | Soil Loss                                         |             |
|--------------------|---------------------------------------------|--------------------------------------|---------------------------------------------------|-------------|
|                    |                                             |                                      | (cubic ft. soil per 100<br>lin. ft. of skid road) |             |
|                    |                                             |                                      | First Year                                        | Second Year |
| 0-20               | 0-132                                       | 13                                   | 44                                                | + 15        |
| 0-20               | 132-264                                     | 0                                    | —                                                 | —           |
| 21-40              | 0-132                                       | 23                                   | 70                                                | + 5         |
| 21-40              | 132-264                                     | 5                                    | 104                                               | 24          |

Table 1 indicates that erosion has ceased on all except the steepest and longest slopes in the area under study. Skid roads built on lesser slopes and shorter distances show deposition rather than erosion. Field observations indicated that much of the deposition is in the nature of accumulation of organic matter such as leaves, twigs and lower herbaceous plants which were caught in the road and decayed.

A more detailed report on the trend of erosion with time is in the making.